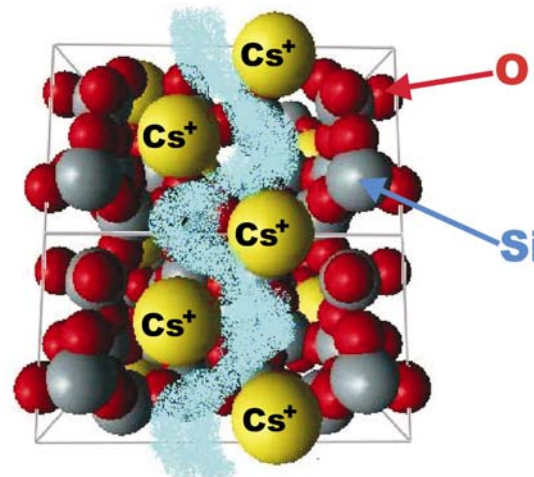


Finally, Thermally Stable Electrides

James L. Dye and James E. Jackson, Michigan State University, DMR-9988881

Recent publications in *Nature*¹ and *Science*² that report work in Japan, as well as our recent papers^{3,4} have demonstrated the synthesis of *inorganic electrides* that are stable at room temperature. As described in our recent *Science* Perspective⁵, electrides are crystalline compounds that have electrons trapped in regular arrays of sub-nanometer cavities. Their optical properties, weak electron binding, and semiconducting to near-metal conductivities make them promising candidates for cold electron emitters, infrared detectors, optically written conducting wires and optical memories^{1,2}.

Our goal to make similarly stable *organic* electrides (as we did with salts that contain alkali metal anions⁶) is close to success with the recent synthesis of a chemically stable strong complexant for sodium and potassium ions.



An inorganic electride⁴ made by adding cesium metal to a pure silica (SiO_2) zeolite. The cesium forms Cs^+ and trapped electrons (blue ribbon).

Two of the authors, Daryl Wernette and Stephanie Urbin, did the research while undergraduates at MSU.

- 1) Hyashi, *et al.*, *Nature* **419**, 462 (2002).
- 2) Matsuishi, *et al.*, *Science* **301**, 626 (2003).
- 3) Ichimura, *et al.*, *J.A.C.S.* **124**, 1170 (2002).
- 4) Wernette, *et al.*, *Chem. Mater.* **15**, 1441 (2003).
- 5) Dye, *Science* **301**, 607 (2003).
- 6) Kim, *et al.*, *J.A.C.S.* **121**, 10666 (1999).

Education and Outreach

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This NSF-supported research involved students from high school to postgraduate levels as well as outreach to K-12 students in the Lansing, Michigan area. Examples are:

- Drawing on his extensive experience in synthesis of polyamine complexants, Postdoc Mikhail Redko oversaw high school students Ishan Roy* and Jason Becker* in a study of aqueous-phase catalytic hydrogenation of amides to amines, avoiding the usual flammable reagents and forming only water as a byproduct. Undergraduates Anthony Green and Eric Bassett, together with Dr. Redko, continue to extend this effort to develop related "green" conversions of biomass-derived amides, esters and acids to amines and alcohols.

**Nov. '03: Finalists in the Siemens Westinghouse Competition in Math, Science, and Technology*

- Undergraduates Daryl Wernette and Stephanie Urbin studied inorganic electrides (published in *Chemistry of Materials*) under a Dreyfus Senior Scientist Mentor Award to Professor Dye. Daryl is now a graduate student in Materials Chemistry at the University of Illinois. Stephanie intends to pursue graduate studies in chemistry next year.

- Stephanie Urbin participated in the Chemistry Day demonstrations at the Impression Five Science Museum in Lansing, Michigan (see the figure). This event was attended by more than 4000 K-12 students.



Stephanie Urbin demonstrates the cooling power of liquid nitrogen to children during Chemistry Day at the Impression Five Science Museum in Lansing, Michigan.